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ABSTRACT

This report discusses the characteristics, operations, and automation requirements of technical libraries providing services to organizations involved in aerospace and defense scientific and technical work, and describes the Local Automation Model project. This on-going project is designed to demonstrate the concept of a fully integrated library system for technical libraries, combining local library functions with capabilities for participation in a Department of Defense (DoD) bibliographic network. The environment and characteristics of bibliographic networks are described; the automated system capabilities required for network participation are considered; and microcomputers are discussed as cost-effective yet powerful tools for exploiting bibliographic network resources. A discussion of the Local Automation Model project highlights the project background and environment, system concept demonstration, and prototype testing of the minicomputer- and microcomputer-based versions. Future development plans include production system acquisition, expanded gateway access, a common command language, reduction of manual effort, full-text and optical disk technology, and indexing standardization and controlled vocabulary. A list of related journal articles and a list of library software, vendors, and reviews of library software conclude the document. (KM)

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Bibliographic networks provide the means for sharing information resources among geographically dispersed libraries. As part of a bibliographic network, a single library can access a wide variety of bibliographic information, participate in shared cataloging, and acquire holdings (purchase or loan). This paper describes (1) the functions and operations of libraries supporting aerospace and defense scientific and technical work, (2) the environment and characteristics of bibliographic networks, and (3) the automated system capabilities required for network participation. A discussion of the use of microcomputers as cost-effective, yet powerful tools for exploiting bibliographic network resources is included. An automated system being developed for U.S. Department of Defense technical libraries is described. This system integrates local library functions with capabilities for accessing bibliographic network resources, both government and commercial.

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BIBLIOGRAPHIC NETWORKS AND MICROCOMPUTER APPLICATIONS FOR AEROSPACE AND DEFENSE SCIENTIFIC AND TECHNICAL INFORMATION

by

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ABSTRACT

Bibliographic networks provide the means for sharing information resources among geographically dispersed libraries. As part of a bibliographic network, a single library can access a wide variety of bibliographic information, participate in shared cataloging, and acquire holdings (purchase or loan). This paper describes (1) the functions and operations of libraries supporting aerospace and defense scientific and technical work, (2) the environment and characteristics of bibliographic networks, and (3) the automated system capabilities required for network participation. A discussion of the use of microcomputers as cost-effective, yet powerful tools for exploiting bibliographic network resources is included. An automated system being developed for U.S. Department of Defense technical libraries is described. This system integrates local library functions with capabilities for accessing bibliographic network resources, both government and commercial.

INTRODUCTION

Throughout the public and private sectors, organizations sponsor or conduct scientific research to support development of new products or services. Research and development spending in the U.S., including both the private and federal government sectors, will total $122 billion for 1986. Top U.S. corporations spent $48.8 billion in 1985 on research and development, a full 3.1 percent of sales [1]. Since 1978, the U.S. Department of Defense has allocated over 10 percent of its budget to research and development [2]. Regardless of sector, research and development represents an investment in the future -- future economic success for private companies and future quality of life for a society. Private sector companies fund research on the basis of risks and rewards of profitability. Governments conduct or sponsor research in areas where the private sector cannot economically justify participation: areas of high risk of failure, or where development of a commercially valuable product cannot be assured.

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Original or applied research, by its very nature, is both a consumer and a producer of technical and scientific information. Researchers scour available technical and scientific information to prevent duplicating the work of others or to gain an advantage by building on the results of others. Depending on the proprietary nature of the findings, researchers may publish research results for the benefit of others working in the field or to establish rights or claims to the commercially valuable by-products of the research. Most research centers and laboratories, whether private or government, provide information services to staff members through technical libraries or information centers.

(Throughout this paper, reference is made to both technical libraries and information centers. In some instances, the designations are not interchangeable. In addition to offering the traditional library services, information centers provide more "information processing" services -- compilation, analysis, synthesis -- than technical libraries. In the U.S. Department of Defense, the term "information analysis center" is used to designate these organizations. However, the same automation requirements apply to both types of organizations when considering their common, fundamental objective: providing bibliographic information services to a community of patrons working in aerospace and defense industries or government agencies. The designation of "technical library" is intended to encompass the bibliographic information services provided by information centers.)

This paper focuses on the characteristics, operations, and automation requirements of technical libraries providing information services to organizations -- private and government -- involved in aerospace and defense scientific and technical work. These technical libraries have the following general characteristics in common:

- They are affiliated with and provide services to an organization performing original or applied research and experimentation, testing, or evaluation.
- The work is technical in nature, but can encompass social, as well as physical sciences, mathematics, or engineering.
- Patrons need general scientific and technical reference services, but will tend to have very specific subject interests reflecting the objectives or assigned missions of the laboratory or research center.
- As a result of patron interests, the library will maintain a local collection of bibliographic materials (books, technical reports, journals, serials) tailored to patron needs.
- To complement the local collection, the library must also rely on a broad range of external resources (on-line bibliographic catalogs, document distribution services, book sellers, and other libraries).

BIBLIOGRAPHIC RESOURCES

Technical libraries call upon a mix of internal and external bibliographic resources to meet patron needs. Internal resources are the catalogs, automated systems, and holdings belonging to and

contained within the technical library and its facilities. External bibliographic resources -- those not belonging to or contained within the library -- include both commercial and government data bases, document distribution services, interlibrary loan agreements, book sellers, and commercial subscription services. Even information specialists and reference librarians of other libraries, if conveniently available, can be considered external resources. Commercial and government data bases contain citations to (or even full text of) books, serials, journals, and technical reports.

Technical reports are unique to the scientific and technical information community: they document procedures and results of contemporary research and focus on a comparatively limited scope of technology or science. Unlike books or monographs, technical reports allow rapid, timely dissemination of research findings. Unlike serials or most journals, technical reports can be used to limit distribution of research findings to a select community of readers. This distribution limitation can be based on protecting national interests (security classification restrictions) or to protect the proprietary information of private organizations from competitors.

Over 20 years ago, the U.S. Library of Congress offered a standard format for exchanging book, monograph, and journal citations on magnetic tape. Referred to as MARC -- machine-readable cataloging -- the format is the de facto catalog citation standard for countless libraries throughout the world. Consequently, many automated systems used to catalog and retrieve book and monograph citations have been designed and implemented around the MARC magnetic tape citation exchange format. In contrast, there is no similar standard for cataloging and subsequently exchanging technical report citations.

Over 2,000 commercial and government data bases are available throughout the world [3]. These range from readily available commercial sources (e.g., DIALOG, SDC/ORBIT, Karlsruhe, PASCAL, DARC) to government data bases where access may be restricted, because of national security or proprietary interests, to a closed community of users. For commercial data bases, access is restricted only by a user's ability to establish a dial-up telecommunications connection to the service and the ability to pay the going rate for the service. In comparison, access to many government data bases is based on the user's participation in or contribution to sponsored research. Access may mean permission to connect to (via telecommunications lines) and search a data base directly, or it can also mean access to data base contents through an intermediary -- an information specialist or reference librarian. Within the defense and aerospace scientific and technical information community, bibliographic data bases or related services are provided by the U.K. Defense Research Information Centre, the European Space Agency, the U.S. Defense Technical Information Center, and the U.S. National Aeronautics and Space Administration. These organizations serve government and government contractors participating in aerospace and defense scientific and technical research and studies.

While there is a wealth of publicly and privately available scientific and technical information, there is little commonality among data bases with regard to citation format, indexing structure and terminology, or retrieval language. As a result, users must learn the structure, content, and retrieval language of each data base accessed. Even more fundamentally, the mechanics of simply connecting to different data bases -- selecting the correct communications protocol and terminal characteristics

(number of data bits, parity, number of stop bits, etc.), dialing the correct telephone number, and executing the correct log-in steps -- can differ widely. Mastering all the aspects of searching several different bibliographic data bases is a formidable challenge for the information specialist or reference librarian. It can be an insurmountable barrier to occasional users, such as scientists, engineers, and researchers.

Access to on-line bibliographic data bases provides the tools for identifying information of interest to patrons. However, the objective of the technical library is to deliver the actual work -- technical report, book, journal article -- to the patron. With the exception of a few full-text data bases, patrons receive scientific and technical information in printed media: paper copy or microform. For items not contained in the local collection, this means locating a source (which may be different from the source of the citation information), placing an order for purchase or loan, tracking delivery to the patron, and perhaps returning a loaned item or cataloging a new item for addition to the local collection. This process is time-consuming for the library staff, limiting the number of requests that can be handled. It is also frustrating for the patron, who may perceive the process as slow and unresponsive to his or her needs.

As a complement to reference services provided to patrons, technical libraries perform original cataloging of new holdings, many of which are published by the research center or laboratory served by the library. In many cases, the publications of the research center or laboratory are requested by other centers or laboratories. The library may have responsibility for this secondary distribution. The publications may be eligible for cataloging in a central data base shared by other technical libraries or information centers in the research community. As is the case with the U.S. Defense Technical Information Center, not only is the citation cataloged into a central data base (the Technical Reports data base), but the document is available for distribution on request from authorized users.

Regardless of the source of new holdings -- locally published technical reports, purchased materials, loaned items -- the library must create and maintain a record of descriptive, and in most cases, subjective bibliographic information. This is the essence of a local bibliographic catalog. Descriptive information is taken from the title page of the holding; subject information is derived from the contents by a cataloging specialist. For loaned items, a minimum of information is kept to allow circulation control. For items added to the local collection, more extensive bibliographic information is retained, facilitating retrieval of the document in accordance with subject content and descriptive information.

In contrast to the manually intensive interlibrary loan process, cataloging is predominately an intellectual effort augmented by manual effort for typing catalog cards or for keyboarding the bibliographic information into an automated system (the latter being preferable and consistent with the thrust of this paper). As with interlibrary loans, staff size and productivity influence the amount of original cataloging a library can do as part of adding items to the local collection. In the case of locally published technical reports, the catalogers in the library serving the research center or

laboratory are subject matter experts when it comes to developing subject indexes, terms, and key word lists for those reports.

In most cases, the cataloging and indexing subject matter expertise is lost when the holding is acquired by other libraries. The report will be cataloged again as a new holding in another library, consuming scarce intellectual and manual effort in the process. This occurs every time another library acquires the report. Over and over again, effort is duplicated and essentially wasted because the citation, unlike the actual report, was not "acquired." While libraries may catalog reports using slightly different formats, there is strong commonality in the information kept. Even if the entire citation could not be used, the portion used would still reduce duplication of manual and intellectual effort and make the library staff more productive.

TECHNICAL LIBRARY FUNCTIONS AND PROCESSES

Translating functions and processes into computer system requirements is the first step toward developing or selecting a system tailored to the special needs of technical libraries. For technical libraries, participation in bibliographic networks must be integrated with local collection management functions. This carries over to the design and development of automated systems for technical libraries. It is counterproductive to burden the library staff with different computer systems, procedures, and languages for each external resource used by the library. Rather, it is advantageous to design and implement a single, integrated automated system with capabilities for local collection combined with capabilities for accessing resources through bibliographic networks. The objective is to integrate access to network resources -- book sellers and subscription services, bibliographic data bases, document distribution services -- with access to locally maintained resources -- a local collection of holdings, a local catalog, circulation records.

A brief description of technical library functions follows. It is presented to establish general automated system requirements for libraries participating in bibliographic networks. Accordingly, access to both local and external bibliographic resources is considered. The following library functions are considered in developing system requirements: acquisition, cataloging, reference, and circulation management and control.

Acquisition

Acquisition involves locating sources (book sellers, vendors, government agencies, other libraries) for obtaining new holdings, ordering and tracking the status of new holdings, accounting for expenditures against an acquisition budget, and tracking and returning items obtained on loan. Ordering and claiming serials on subscription are also included as part of the acquisition function. All holding types -- books, monographs, serials, journals, technical reports -- are covered under a single acquisition function. Separate processes may be used for each holding type, but the processes support a common function.

Cataloging

All types of holdings are subject to cataloging: books, monographs, serials, journals, microfiche, and technical reports. Cataloging consists of creating a skeletal record when new items are ordered, developing the descriptive cataloging record from holding information, selecting subject terms for indexing, and editing citations as information on the record changes. Cataloging includes (1) adding new citations to a catalog of holdings maintained locally by the library and (2) sharing citations cataloged in the local system with other libraries.

Citations can be shared via two media: printed or electronic. The benefit of sharing citations electronically is reduced manual effort from a reduction in keyboard entry of information. Citations may be shared electronically by:

- cataloging directly into a shared, central data base
- transferring citations from the local catalog to a central data base (uploading)
- allowing access to the local data base by other libraries for the purpose of "withdrawing" or "downloading" citations.

Of the three methods of sharing citations electronically, the last two are preferred over the first when a local catalog is maintained. Assuming that a central, "closed community" catalog is maintained, as is the case, for example, at the U.S. Defense Technical Information Center, transferring citations from the local catalog is preferable. If the catalogs use different formats for citations and citation contents, translation to a standard interchange format is required. Where the translation takes place is a function of policy, negotiated between cataloger (technical libraries) and data base owner.

Technical reports published by the laboratory or research center supported by the technical library will be first cataloged by the library. As other libraries request the holding, they can be given access to the citation as well. Conversely, when a new holding, other than a locally published report, is obtained, its citation, if it exists in an electronic medium, should be obtained. This practice should be applied to other holding types, within limits imposed by availability of machine-readable citations and copyright protections.

Reference

With a catalog of citations to holdings held in a local collection, library staff members search for and select resources that can be provided to the patron almost immediately. However, searching the local collection is not totally adequate. To avoid costly, wasteful duplication of research effort, a more comprehensive search of closed community and publicly available resources is essential. This means gaining access to one or more external data bases; performing a thorough, comprehensive search; and creating a composite bibliography -- by merging the search results from more than one source --sufficient to meet a patron's needs.

Functionally, reference consists of selecting target data bases to search, searching external and local data base(s), downloading citations from external sources, merging citations to create a patron bibliography, and reviewing the bibliography with the patron. Citations contained in the bibliography provide information to the acquisition function, when a patron requests a holding not in the local collection.

Circulation Management and Control

Circulation management and control includes registering patrons (establishing access privileges and security clearances, as necessary), charging holdings out to patrons, charging holdings out on loan to other libraries, discharging holdings returned by patrons and from loan, maintaining information on the status of all holdings, and tracking bindery operations for serials and journals. In technical libraries with classified or proprietary holdings in the local collection, document inventory and signature accountability of documents is a necessary and integral part of circulation management and control.

Other Functions

The preceding four functions account for the core of library operations and, consequently, form the core functions of an automated system supporting the library. However, other library management functions are amenable to automation and should be considered when designing or selecting a system. These other functions can be included as part of the basic system, but more likely, as augmentations to the basic system software because of their functional heterogeneity. Other functions suitable for automation within technical libraries include word processing, generalized data base management (creating, updating, and retrieving from text or numeric data bases), and management reporting.

Summary of Functions and Processes

- Acquisition
  - Locating sources
  - Ordering and tracking (booksellers, reprint services, document services)
  - Interlibrary loans (borrowed items)
  - Budget and accounting
- Cataloging
  - Downloading, translating, and reformatting citations
  - Creating original citations
  - Transferring citations to other on-line catalogs
- Reference
  - Locating and selecting data bases

- Local collection searching
- Searching external data bases
- Downloading, merging, and duplicate reduction
- Post-processing (sorting, concordances, permuted listings)
- Storing, transmitting, and reviewing citations

- Circulation Management and Control

  - Charging and discharging holdings
  - Registering patrons
  - Interlibrary loans (loaned items)
  - Classified and proprietary information accountability

- Office Automation and Management Support

  - Word and text processing
  - General data base management (text and numeric)
  - Management reporting
  - Electronic mail.

LOCAL SYSTEM AND NETWORK INTEROPERABILITY

There are trade-offs in designing and configuring an automated system for both local library functions and bibliographic network functions. If existing, shared external resources (e.g., data bases, ordering or book seller services, document distribution services) are to be accessed, their capabilities, features, and limitations must be accommodated and, in some cases, compensated for in the local system. Seldom will a community of libraries have the opportunity to set requirements for both local systems and shared network resources without being constrained, at least in the short term, by existing capabilities. Furthermore, government and commercial data base providers and other vendors (book sellers) must meet the needs of a wide variety of users. In general, you use the service as provided, with many vendors willing to accommodate broadly supported (by users) changes as resources permit.

The lack of standardization -- in command and retrieval languages, data base structure, citation formats, indexing terminology -- among data bases and related bibliographic services places an enormous burden on the user. Standardization, as a short-term solution, is economically out of the question for most vendors and suppliers. Over time, standards will be established and implemented, given the economic incentives to do so. For example, the EURONET/DIANE project produced a common command language intended to be used across a number of bibliographic data bases available in European countries. The International Standards Organization has proposed a standard command set and syntax for bibliographic retrieval using on-line systems. A related effort has produced a draft of a bibliographic retrieval command language within the United States.

While attempts at establishing standards go on, the lack of standardization can be compensated for in local automated systems. Most notably, the local library computer system can be used to translate commands between systems and a common or standard command language, translate citations from external systems to a local format, and significantly reduce the burden of establishing connections to external systems and data bases.

Relying on centralized versus decentralized (distributed) processing is the fundamental trade-off in designing systems for participation in bibliographic networks. At one extreme, all computer processing (hardware and software) and information resources (data bases, distribution services) are centralized, with no duplication of capabilities or resources. At the other extreme, resources are scattered geographically and organizationally, and every network participant owns and maintains a substantial collection of resources, with much duplication. The reality of libraries participating in bibliographic networks lies somewhere in between the two extremes. Economics and technology dictate the specific mix of centralized (shared) resources and distributed (with some level of redundancy) resources. Considerations in arriving at the mix of resources include response to user requirements (timeliness and functionality), required processing power, telecommunications versus local system costs, and comparative costs of alternatives.

Acquisition

Several vendors offer on-line ordering of books and serial subscriptions. For example, in the U.S., Ballen offers dial-up access to information so that users can place and track book orders. EBSCO and FAXON offer on-line subscription services, claims requesting, and ordering of back issues for serials. In addition, funds accounting and budget tracking capabilities provide useful information for library management. These three services are self-contained in that the complete application runs on a central computer and is accessed by the user through dial-up communications lines. Access requires a terminal capable of dial-up, asynchronous communications.

In offering these services, companies attempt to provide a complete acquisition service to libraries. That is, each company may offer on-line ordering, order tracking, expense accounting, and budget management. However, most libraries must rely on more than one of these companies to meet patron requirements. For example, the library will have one service for periodical literature, another for scientific and technical books, and yet another for government publications. This fragmentation of the systems supporting the acquisition function requires the staff to use multiple, dissimilar procedures to perform one function. Using a single vendor is not a solution. Using a single procedure for multiple vendors is a more realistic approach. What "standard" set of procedures should each vendor adopt so as to provide a single procedure? In all likelihood, agreement on a standard procedure will not occur. It falls to the user -- the technical library -- to rationalize the multiple procedures into a standard set of procedures suitable for effective library operations.

Use of on-line acquisition services must be integrated with the local catalog as well. For example, the library staff must be able to determine whether an item requested by a patron is already on order. To do so may require dialing into several on-line ordering services to answer the question. Alternatively, order information from each service used can be kept in the local computer system.

This information must be integrated with the local catalog, else little is gained by requiring the staff to search two disjoint local data bases.

Similarly, accounting and budget information available on several different on-line services must be consolidated to reflect total acquisition expenditures and balances. Where does this consolidation take place? On one of the vendors' systems? Perhaps, but more appropriately, the library will want to maintain consolidated acquisition accounting and budget information on the local computer. However, the information in the local system must reflect the latest information available from the vendor systems. Timeliness and accuracy of the information would be improved if there were a way of automatically updating the local system with data from the dial-up services.

To use on-line ordering systems effectively, the local library system must be the focal point for consolidating order, accounting, and budget information. The local system duplicates some of the on-line services capabilities: limited order tracking (with whom was the order placed, when, when is delivery expected?), expense accounting (by item, by vendor), and budget management (what has been expended vs. what was budgeted for, projections of future budget based on past requirements). However, the local system consolidates information from all sources, providing an integrated view of the acquisition function. The local system complements the on-line services in that skeletal citations, created from order information when the order was placed, can be searched as part of a local catalog of citations. This enhances the reference services provided to patrons and reduces duplication of orders for new items.

Technical libraries participate in interlibrary loan networks, largely for access to serials, specialized journals, and books. Nation-wide and regional interlibrary loan networks make it possible for participating libraries to access a rich and diverse collection of holdings without the cost of buying each item. Several networks offer dial-up access for locating and requesting holdings through interlibrary loan. A central computer system is used to maintain a union list of holdings of libraries in the network and to track loans among participating libraries. As with book ordering and subscription services, a library may belong to more than one interlibrary loan network.

Items obtained through interlibrary loan are subsequently charged to library patrons. To track the borrowed item, the library staff must create a temporary bibliographic citation for circulation management and control. If bibliographic information on the borrowed holding is available from either the lending library or the interlibrary loan network computer system, it can be transferred electronically to the local system. This eliminates the need to keyboard the information into the local system manually, while making the information readily available to the library staff.

Cataloging

Libraries may choose to catalog local holdings into a central data base accessible on a bibliographic network. This eliminates the need for a local computer (for cataloging), but places the library in the position of accepting the responsiveness and availability of someone else's computer and software. This approach has been used for years in the U.S. for monographs, books, and serials cataloged using the OCLC, Inc. on-line system. In taking this approach, the library must be satisfied

with the functionality, responsiveness, and limitations of the central system, not only for cataloging but for reference as well.

While sharing a central catalog may be satisfactory in some circumstances, most libraries need and can justify the responsiveness of a locally maintained catalog. Among a community of libraries with common interests and objectives, a central catalog offers the means for expeditiously sharing bibliographic information. Local collections and catalogs maintained by individual libraries provide responsiveness to patron needs, while shared cataloging into the central catalog promotes rapid dissemination of technical and scientific information. Libraries participate in shared cataloging with the expectation of getting benefit in return. This would be the case if the central catalog contained citations to holdings not readily accessible elsewhere, as is the case with classified or proprietary technical reports. The central catalog is then an extension of, not a replacement for, a local catalog.

Shared cataloging -- cataloging into a local system and into a central system -- can result in a duplication of effort for participating libraries. If duplicate entries are required for both the local and central catalog, libraries will be reluctant to participate, little improvement will be made in timely dissemination of information, and participation will eventually cease. If a single entry can be made in the local system and that same entry, with minor modifications, electronically sent to the central data base, then shared cataloging will cost participants little.

Reference

Library staff members must be able to search a local catalog by subject (key words, index terms, or free text), title, author, publisher or source, date of publication, and type of holding. This provides the patron with rapid access to scientific and technical information held in the local collection. To complement information contained in a local collection, library staff members must have access to external bibliographic data bases. In essence, these external data bases become an extension of the local catalog. However, searching both a local catalog and several external data bases can be time-consuming and costly. Managing the flood of information resulting from these searches can be overwhelming, resulting in poor service to patrons.

It is clearly advantageous to have access to external data bases. However, it is equally advantageous to have a local system with a catalog to local holdings. To integrate these two resources, the local library computer system must be able to connect users to the external sources, allow searching of the data bases, and support transferring citations from remote systems to the local system. Once on the local system, the citations can be merged together with local citations, sorted, searched again (without the connection costs associated with remote systems), and further processed for delivery to the patron. By having this capability in a single local system, the library staff create comprehensive, relevant bibliographies for patrons with little duplication of effort and with a significant reduction in manual effort.

Circulation Management and Control

Libraries participating in interlibrary loan networks often lend, as well as borrow items. Tracking items on loan to other libraries is essential for preserving the local collection. Through an interlibrary loan network, technical libraries can electronically share citations for loaned items with borrowing libraries. This speeds the loan process and can result in a more accurate circulation record for the borrowing library, reducing the chance of losing an item or delaying return to the lending library.

HARDWARE AND SOFTWARE CONSIDERATIONS

Participation in a bibliographic network requires little more than a terminal and modem. However, this austere configuration provides no local processing capability: no local catalog, no capability for local applications software, and, most important, no way for integrating local resources with those available externally. More processing power (more than a terminal and modem) is needed to effectively and productively meet the automation needs of libraries supporting aerospace technical and scientific research. With today's technology in microcomputers and applications software, it is possible to implement a system capable of supporting local collection management and accessing external, on-line bibliographic resources. The challenge is integrating the hardware and the applications software needed for full functionality.

Hardware

Microcomputers are appealing for use in library automation. They are comparatively inexpensive, yet offer adequate processing power for specialized applications. Micros operate without a great deal of operator intervention and within environments commonly found in any office or library. This section contains a brief discussion of hardware characteristics needed for library automation.

Microcomputers can be categorized by the number of users able to access the system concurrently. Many micros are single-user systems. These can be useful for network and library applications, but trying to support multiple functions concurrently -- reference, circulation, cataloging -- causes contention among staff members and hinders library operations. A multi-user system is preferable for these very reasons: several users can access the whole range of system functions, responding as needed to changes in library work flows and patron requirements. In addition to supporting multiple users concurrently, the computer should be multi-tasking. That is, each user can concurrently perform more than one process (execute more than one program at a time, for example). This is essential for effectively integrating local functions with capabilities for accessing bibliographic network resources.

Communications capabilities are at the core of any system supporting bibliographic network access. Most on-line bibliographic services -- book sellers, subscription services, data bases -- provide users with dial-up, asynchronous communications. For reasons of economy and responsiveness, these services offer access at 1200 baud or higher. Modems are available to support higher dial-up speeds

reliably, and many services are offering the higher speeds. To facilitate dial-up access, modems are available with built-in automatic dialers for both pulse and tone dialing.

Disk storage costs have dropped dramatically since 1983, while device capacity has risen. Disk storage devices provide the responsiveness, economy, and reliability needed for maintaining a local on-line bibliographic catalog. For estimating disk storage requirements for catalogs, allow 2.5 kilobytes for each citation stored, plus an additional 60 percent for storage overhead. Allow 10 to 15 megabytes storage for the operating system and utilities and 5 to 10 megabytes for applications software. For example, with a 60-megabyte Winchester technology disk drive, a catalog of approximately 10,000 citations can be supported. Downloading citations and creating merged bibliographies requires additional disk storage. However, today's microcomputer systems can support multiple, high-density disk drives, providing as much as 1 gigabyte of storage on so-called "super" microcomputers.

The following hardware configuration is based on equipment readily available for library automation. The system as configured will support two users, but can easily be expanded to eight. Disk storage is estimated on a collection of 25,000 holdings, with allowances for downloading from external data bases. Concurrent access to two external, on-line services is supported (this can also be readily increased). This configuration represents the minimum for a system capable of both local collection management and access to external bibliographic network resources. It has an estimated purchase price of less than $20,000 (U.S.):

- A multi-user, multi-tasking microcomputer central processing unit with 2 megabytes of real memory, 8 serial (asynchronous) ports, printer interface, disk and tape unit controllers, and operating system
- Two 80-megabyte Winchester disks with tape cassette back-up
- Two terminals and cabling for local connections
- One printer
- Two auto-dialing modems (1200 baud).

Software

Rather than discussing specific applications software, this section presents a brief description of the characteristics needed for a local collection management system integrated with network access capabilities. References for use in identifying and selecting software suited for local collection management functions -- acquisition, cataloging, retrieval, circulation management and control -- are included in an appendix. These references provide lists of available products and contain reviews of software for library automation.

Library Functions. Software supporting local collection management functions (i.e., acquisition, cataloging, retrieval, and circulation management and control) must be well integrated.

Files created for one application must be shared with another application requiring the same information. For example, data entered or added by a cataloger must be automatically shared with circulation management and control applications. Moving from one function to another is accomplished through a consistent set of commands, rather than through hierarchical menus or apparent execution of individual programs.

Detailed lists of software features and capabilities for general and technical library automation are contained in References [4] and [5], respectively. The following software features are highlighted to point out the key areas of interoperability between local collection management and access to external resources:

- Acquisition
  - Accept data downloaded from external data bases into acquisition tracking, accounting, and budget files maintained on the system
  - Automatically reformat data from external sources into format required for local files
  - Share descriptive bibliographic information (skeletal citations) developed to track acquisitions and borrowed items with retrieval programs used for searching the local catalog
  - Share skeletal citations with cataloging applications to reduce the duplication of data entered for new or borrowed holdings
- Cataloging
  - Allow the cataloger to easily edit and reformat citations downloaded from external data bases for addition to the local catalog
  - Automatically reformat downloaded citations to the local format for frequently used data bases
  - Extract citations from the local catalog for electronic transfer to other systems
  - Automatically translate citations from the local catalog format to the formats required by data bases to which citations are frequently sent
- Retrieval
  - Concurrently search the local catalog and selected external data bases using a common command language
  - Provide real-time feedback to the searcher on search results, and permit search refinement

- Download citations from external data bases, translate them into a common format, and merge them in with citations from the local catalog

- Search the merged set of citations, sort them by user-specified keys, and provide summary information useful to the patron.

Network Access. Applications software for accessing and exchanging information with external bibliographic resources must work in concert with software for local collection management. Network access software must perform the following functions to make the integration effective:

- At the request of the user, dial, connect, and log into a remote data base
- Control the flow of information between a user's terminal and the remote host
- Direct information from a user's terminal to intermediate programs and then into a remote data base (e.g., programs for command translation)
- Direct information from remote data bases to temporary files or intermediate programs on the local system (e.g., citation format translation programs)
- Allow the user to communicate with both the local system and the remote system, as required.

Despite a lack of standardization in communications protocols, command languages, and data formats, accessing external data bases can be simplified for the user. With "intelligent gateway" [6] features, a computer system can provide automatic connections and log-ins, perform concurrent searches of multiple, heterogeneous data bases, and capture information on a local system. Specific capabilities have been demonstrated for concurrent searching, downloading, and post-processing bibliographic information [7]. These features can be provided in a centralized computer, acting as an intermediary device between the user and the external data bases [8]. Alternatively, a local system can be equipped with gateway capabilities, offering the added benefit of concurrently searching a local catalog and several external data bases [9].

A microcomputer-based library system can provide gateway access to the most frequently used bibliographic network resources, providing a link between local functions (acquisition, cataloging, retrieval, and circulation management and control) and network services (book sellers, subscription services, document distribution services, bibliographic data bases). For less frequently used network resources, the local system can access a centralized gateway computer. This central gateway in turn contains the translators and access routines for a greater number of data bases, consistent with its greater processing and on-line storage capacity. The central gateway machine can be shared by many libraries, making it economical and practical for even a very small library to use several hundred external bibliographic data bases.

THE LOCAL AUTOMATION MODEL PROJECT

The discussion to this point has been general in nature: broad characteristics of technical libraries, bibliographic networks, and library functions and processes. The following is a description of an on-going project sponsored by the Defense Technical Information Center of the U.S. Department of Defense. The objective of the project is to demonstrate the concept of a fully integrated library system for technical libraries, combining local library functions with capabilities for participation in a Department of Defense-wide bibliographic network.

Background and Environment

There are over 200 technical libraries and information centers located throughout the United States supporting the DoD research centers and laboratories conducting research projects. While the technical libraries all operate within the Department of Defense, each library is unique in responding to the management direction and patron needs of the laboratory or research center it supports. Each library reflects the emphasis and orientation of the research work supported, resulting in a wide range of library sizes, a variety of operating conditions and methods, and diverse, unique local collections. What these libraries have in common is the need to integrate bibliographic resources from three distinct sources. First, each library maintains a local collection consisting largely of scientific and technical reports (some of which are classified and restricted in availability), books, serials, and journals. Second, all retrieve citations and order copies of technical reports from a central source within the Department of Defense -- the Defense Technical Information Center (DTIC). Third, these libraries search and retrieve from commercially available bibliographic data bases containing information on science, technology, engineering, and other general research areas.

The Defense Technical Information Center is the information clearinghouse for scientific and technical information within the Defense Department [10]. In addition to operating an on-line catalog -- the Technical Reports (TR) data base -- of citations to over 1.5 million titles, the Center actively seeks ways of improving the flow of bibliographic information within and into the Department of Defense. To this end, the Center sponsors and conducts research and development in areas of information cataloging and indexing, storage, and retrieval. With the objective of speeding access to scientific and technical information, DTIC sponsors research in organizational programs and complementary computer-based tools for resource sharing within the Defense community. These include (1) development of on-line data base directories (metadata), (2) common command language-driven access to external commercial and government data bases via intelligent gateways, and (3) a shared cataloging program encompassing technical reports produced within the Department of Defense.

Defense Department technical libraries fill two important roles in promoting timely dissemination of current research results. Naturally, the technical libraries support their patrons with traditional reference services: bibliographic searches, preparation of research bibliographies, and development of project reference material. In addition, many technical libraries are charged with

distributing technical reports and studies prepared by the staff of the laboratory or research center supported by the library.

In general, publications originated by the supported laboratory or research center are cataloged and shelved at the supporting technical library. Working in conjunction with the Defense Technical Information Center, the libraries are contributing directly to the centrally maintained TR data base through shared cataloging. This program is called the Shared Bibliographic Input Network (SBIN) [11]. Since fiscal year 1982, this program has accounted for about seven percent of the document citations entered in the TR data base. Since fiscal year 1982, the number of sites participating in the SBIN program has grown from 30 to 71, yet the level of input remains about the same: 1,800 to 2,200 citations per year [12]. It is estimated that SBIN sites could contribute anywhere from a third to a half of all citations entered in the TR data base [13]. This means more citations get into the central data base sooner, contributing to timely dissemination of technical information.

However, SBIN participation represents duplication of effort for most libraries: a citation is entered into a local catalog and then re-entered (in compliance with a different set of cataloging rules governing format and subject indexing) a second time into the TR data base. To promote shared cataloging, this duplication of effort must be eliminated or significantly reduced. The benefits of doing so are expanded, rapid access to new technical information.

Despite the diversity in organization, management, and patron orientation, technical libraries perform the same basic functions as any other library: cataloging, reference, and circulation management and control. A local collection, tailored to patron needs, provides the core resources. In general, all DoD technical libraries rely on the DTIC TR data base as the on-line reference source of DoD-related technical report citations. In addition, most libraries rely on commercial bibliographic sources -- DIALOG, BRS/SEARCH, LEXIS/NEXIS, OCLC, ORBIT -- and other government data bases -- chiefly NASA RECON and the Department of Energy RECON -- to meet patron demands for information. Regardless of the size, each technical library must maintain and exercise a range of bibliographic resources to meet patron needs.

Blending together the mix of resources required by Defense Department technical libraries complicates the process of developing automated systems to support library operations. While the process is further complicated by the nature of the local collection -- technical reports vs. monographs, restricted vs. open access to holdings -- there are clear advantages to pursuing integrated systems for technical library automation. Through integration, local collection access can be linked with access to external resources -- government or commercial -- providing a powerful reference tool well suited to meet the special demands of closed and open literature access.

Furthermore, the manual and intellectual effort spend on cataloging locally produced technical reports can be shared with other libraries through shared cataloging. That is, given that the citation is created and entered into a local catalog, the computer can be used to translate or reformat the citation (if necessary because of different catalog formats and cataloging rules) and transmit the citation to a central data base such as the DTIC Technical Reports data base. Once entered into the

Technical Reports data base, other members of the technical and scientific community have almost immediate access to the latest research results.

Concept Demonstration

The challenge in developing and implementing automated systems for DoD technical libraries centers on integrating local collection management functions (reference, cataloging, and circulation) with access to external resources (both for reference and shared cataloging). This extends the concept of integrated library systems to encompass access to external resources. With such a system, library staff members can effectively and economically provide comprehensive, broad-based reference services taking advantage of diverse resources. Timely dissemination of current research results from shared cataloging by taking full advantage of local library resources and eliminating duplication of intellectual and manual effort in the cataloging process.

While defining the characteristics of an integrated system for technical library automation appears straightforward, a survey of existing software products indicates that no single commercial or public-domain system provides the capabilities needed to implement the concept. All the technology (software, hardware, and telecommunications) does exist, however. What is needed is an approach for modifying (as required) and assembling the available technologies into a truly integrated system running on one computer and accessible by any user over a single video display terminal. Development and demonstration of a system meeting these requirements became the objectives of the Local Automation Model project.

The Defense Technical Information Center initiated project development at the request of Shared Bibliographic Input Network member libraries. The shared cataloging experiment was burdening technical libraries because holdings (technical reports) had to be cataloged twice -- once in the local catalog and then again for the Technical Reports data base. While DTIC was benefiting from technical libraries' sharing cataloging responsibilities, the libraries appeared to bear a burden of effort disproportionate to the apparent benefits.

Serving as the focal point for the development effort, DTIC contributed a significant portion of the initial funding, supervised the day-to-day activities of the project, and coordinated the involvement of over twenty technical libraries. As such, DTIC shouldered the initial risk of project development, offsetting some of the burden placed on technical libraries already participating in shared cataloging. As a result, no single library would have to bear the risk of system development by itself, broadest possible user participation was encouraged, and scarce system development resources were focused on a problem likely to yield significant pay-offs throughout the Department of Defense technical and scientific community.

The primary objective of the Local Automation Model project is to demonstrate the concept of an integrated system handling performing local collection management functions, coupled with access to external bibliographic resources. The results of the project would be a local computer system available for implementation by SBIN member libraries. The project was structured in phases consistent with a typical automated system development life cycle: requirements definition, concept

development, system design, concept demonstration, system acquisition and implementation, and system operation and maintenance. Work on requirements definition began in November 1982, with concept demonstration via implementation of a prototype system originally scheduled for June 1985.

Requirements definition began with visits to representative libraries to conduct interviews with staff members. A list of system requirements and features was prepared and included in a survey sent to 35 libraries participating in the Shared Bibliographic Input Network program. Twenty-five libraries responded to the survey. Respondents indicated the requirements and features considered essential for the system and ranked the requirements and features in order of priority of need.

On the basis of the requirements and priorities established through the survey, a design concept for the system was formulated. The design concept described the requirements to be included in the system and laid out a structure for the system. The design concept was documented and sent to survey respondents for comment [14]. Comments were taken into account in subsequent design work on the system.

Design of the system continued with development and publication of a Functional Description [9]. The purpose of this document was to convey to the user community and potential system developers the characteristics and performance of the system. Within the Functional Description, the software architecture for the system was defined. The operating environment was discussed, along with a statement of hardware features and characteristics needed to operate the system. The development approach for the remainder of the project was outlined in the Functional Description also. The technical library at the Defense Nuclear Agency in Alexandria, Virginia was designated as the test site for the prototype system. As before, the document was sent to participating technical libraries for review and comment.

At this point, the general system characteristics and capabilities were fairly well agreed upon. The processing steps and hardware and software requirements were then documented in a System Specification [15]. The System Specification described the detailed processing steps and sequences required to meet user requirements. Coincident with publication of the System Specification, modifications to the remainder of the development schedule were prepared and announced.

Initially, the system development plan called for demonstrating the system concept using a public domain library system widely known throughout the user community. The package had been modified and enhanced by a commercial vendor who was marketing the package. Unforeseen events halted pursuit of this approach and necessitated selection of an alternative development approach. The immediate problem in pursuing the alternative approach was selecting -- from perhaps hundreds of software products -- a system suitable for concept demonstration at the prototype site.

On the basis of the requirements and design documented for the system, a survey of available software products was conducted. The purpose of the survey was to ascertain the suitability of using existing, commercially available systems for the prototype. If existing software was found to be suitable for the prototype, it would reduce the risk and cost associated with developing software. A

list of 30 critical functions was developed and used to conduct the survey. In all, 66 vendors were contacted and asked to respond the the survey points covering the 30 critical functions. In the first stage of the survey, 33 products were eliminated from consideration, leaving 30 vendors as possible candidates, pending further evaluation. Of the remaining 30, six were finally selected as having suitable functionality and offering the requisite features for the prototype system [16].

Performance benchmarking was used to select a package from among the final six for prototype system implementation. A test plan was prepared detailing the evaluation and scoring criteria used for performance benchmarking [17]. Several organizations provided staff members to participate in the evaluation. Each member of the team used the systems and evaluated them against the criteria listed in the test plan. Benchmarking took over 10 months to complete. The UNICORN System from SIRSI Corporation and BRS/SEARCH (Mini/Micro Version) were selected for the prototype.

To provide simultaneous searching of external sources and the local catalog, an intelligent gateway processor will be incorporated in the system. For the prototype system, a subset of the Integrated Information System (IIS) -- developed and supported by the Technology Information System group at Lawrence Livermore National Laboratory -- will be used. Lawrence Livermore staff members are participating in the prototype development, providing much of the technical and operational expertise required for software benchmarking, package selection, and, of course, integration of the intelligent gateway with local collection management functions.

With an intelligent gateway, users of the local system can be connected to several external systems and data bases via telephone lines. The gateway performs the protocol and syntax translation needed for intercommunication among dissimilar, heterogeneous systems and data bases. Coupled with a common command language -- via a custom-tailored user interface -- the gateway and the library software package are accessible by a user through a single video display terminal providing access to a broad range of information and data manipulation resources.

Progress and Future Development

Minicomputer-based System. Implementation planning for the prototype system began in February 1985 and continued through hardware and software installation. Installation of the hardware for the prototype system was completed in March 1986. Software installation and conversion of existing bibliographic and patron files was completed in April 1986. Training for the library staff was conducted concurrent with software installation and testing. Local system functions -- reference, cataloging, and circulation management and control -- are operational. Installation and testing of the gateway software and hardware will be completed this summer. The hardware configuration for the system is as follows:

- Digital Equipment Corporation VAX 11/750 central processor with six megabytes of real memory, running the UNIX operating system (version 4.2 BSD)

- Two 300-megabyte Winchester technology disk drives with removable head and drive assembles (for use with classified data)
- One 1/2" magnetic tape drive with selectable recording densities of 1600 and 6250 bits per inch
- One high-speed (300 lines per minute) line printer
- Seven VT100-equivalent video display terminals
- Three terminal printers, 200 characters per second print speed
- A secure, asynchronous, 9600-baud network linking the seven terminals and three printers located in the library with the central processor.

The prototype will be evaluated for a year. During that time, other functions may be added, modifications to improve performance and user access made, and other peripheral hardware tested. Experience with the prototype will shape performance requirements and specifications for the production system. Production system acquisition will be accomplished through a centrally managed, competitive acquisition conducted jointly by the Defense Technical Information Center and the Library of Congress Federal Library and Information Network (FEDLINK). The production system will be offered to Federal libraries and information centers, as are other FEDLINK products and services.

Microcomputer-based System. Beyond the 50 to 60 large technical libraries initially targeted by the Local Automation Model project, approximately 200 to 300 other DTIC users could participate in shared cataloging and benefit from gateway access features for reference work. The challenge becomes that of scaling the software and hardware so that a system -- with required features and capabilities -- is available for implementation within any size library or information center.

In April 1985, work began on demonstrating the functions and features of the Local Automation Model project on a microcomputer. Building on the results of the Local Automation Model project minicomputer prototype, system requirements and characteristics were established [18], software packages were examined, and candidates were selected [19]. A prototype system was installed at the Headquarters, U. S. Training and Doctrine Command technical library at Fort Monroe, Virginia. Operation of the local system functions began in March 1986, with implementation of gateway features scheduled for summer of 1986.

The microcomputer version of the system is implemented using the following hardware configuration:

- Altos 2086 central processor with 2 megabytes of real memory, running the Xenix operating system

- 80-megabyte Winchester technology disk drive with video cassette tape input and back-up
- Three IBM-PCs and one Wang PC configured as terminal work stations.

While prototype evaluation is well under way, other significant milestones remain. Some of these are readily accomplished within 6 to 12 months; others, because of greater complexity and broader impact, may take longer.

Production System Acquisition. A plan for acquiring the production system must be developed which accommodates the organizational and managerial diversity found in the DoD technical library community. The acquisition strategy must emphasize competition among the host of potential vendors, but must promote open access to technical data covering protected software so that integrated products can be delivered.

Expanded Gateway Access. Transferring citations between the local system and the DTIC TR data base -- both uploading and downloading -- is sufficient for concept demonstration. In practical application as an integrator of all library bibliographic resources, the system must offer the capability of connecting with and downloading citations from other sources. Expansion of the gateway features of the system to include access other government and commercial data bases is necessary.

Common Command Language. Hand-in-hand with the need to expand gateway access to other sources is the need for a common command language across all resources. Each government and commercial data base has peculiarities that confound command standardization. And each system's unique features may be accessible only through a unique command. However, as access to bibliographic resources expands, the need for even a "lowest common denominator" command set will increase. User demands and economic incentives will guide most commercial suppliers to a common command set or language, if a standard exists. Work by the NISO Z39-G Standards Committee is encouraging in this area [20].

Reduction of Manual Effort. The key to further reductions in manual effort will be found in the use of optical character and bar code readers and in full-text scanning machines. Bar coding and OCR offer the potential for further labor saving in the area of circulation and inventory management. The ability to by-pass the key entry of information through use of image or text scanning will speed cataloging and enhance retrieval by encouraging full-text cataloging. Of these, the integration of bar coding offers immediate benefits to users in Defense Department technical libraries.

Full-Text and Optical Disk Technology. Sharing classified or proprietary information requires special safeguards which affect automated system design and operations. Telecommunications safeguards are expensive and in some cases economically unjustifiable for low-volume transaction rates. Rather than distributed processing of classified or proprietary bibliographic information over telecommunications networks, catalogs can be distributed on optical disk. Given sufficient production volume, copies of large data bases can be inexpensively produced and distributed on optical in a form suitable for rapid searching and retrieval. With optical disk

distribution of data bases, can also have access to the full text of technical reports, rather than relying on traditional distribution of hard-copy and micro-fiche media.

Indexing Standardization and Controlled Vocabularies. A standard or common set of index terms and controlled subject terms will be beneficial for shared cataloging and retrieval within DoD activities and organizations. A vocabulary exists today and is in use by DTIC. Technical libraries argue that the terms are too broad for use in local collection cataloging where a single DTIC term can cover 10 to 25 percent of a local collection's holdings.

SUMMARY

Essentially, the implementation of the prototype systems by the U.S. Department of Defense demonstrates the feasibility of integrating diverse, yet functionally compatible local and bibliographic network resources for technical libraries. Ensuring widest possible access to the results of the Local Automation Model project -- access to production systems acquired as a result of project research and development -- enables individual technical libraries to improve patron services with a reasonable rate of return on system costs and without the risks of going it alone. For the Department of Defense scientific and technical community, implementation of the production systems provides a powerful information management tool supporting timely, comprehensive research, development, and engineering.

The development project sponsored by DTIC has broken new ground in uncovering and resolving the problems associated with technical library automation within the defense and aerospace community. Through the use of powerful, comparatively inexpensive microcomputers, it is possible to link local collection resources effectively and economically with a vast array of bibliographic network resources for any size library. The research results and experience with the microcomputer-based prototype system are valuable lessons learned and can have a significant impact on how other organizations -- both government and private sector -- approach library automation.

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APPENDIX

REFERENCES TO LIBRARY SOFTWARE AND EVALUATIONS

These references contain lists of library software and vendors and reviews of library software. The references cover software suitable for local collection management: acquisition, cataloging, retrieval, and circulation management and control. Other applications of general interest to libraries, such as word-processing, are covered, but not as extensively. The serials referenced have a practice of featuring reviews of library software in each issue. Therefore, no issue or volume numbers are given. These serials are indexed in a number of on-line data bases in the United States.

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